Utilization of Genetically Elite Holstein Cows

R. L. POWELL, G. R. WIGGANS, and H. D. NORMAN
Animal Improvement Programs Laboratory
Agricultural Research Service, USDA
Beltsville, MD 20705-2350

ABSTRACT

Merit of service sires for Holstein cows designated as genetically elite for yield in January 1990 was calculated to determine the contribution of these cows to genetic progress. Service sires were determined from sires of registered female progeny because male progeny were selectively registered. Primary data were 1295 elite cows (top 1%) that had a daughter produced from a mating in the 6 mo following the January 1990 evaluation and 209 service sires for those elite cows. Seven percent of the elite cows were mated to bulls that not only lacked an evaluation but also had generally low pedigree promise. The average economic index of evaluated service sires based on their genetic evaluations for milk, fat, and protein yields was at percentile 91 (ranking based on active AI bulls). Five percent of these bulls were below percentile 50. Although 71% of the bulls were at or above percentile 90, only 13% were at or above percentile 95, which was only slightly greater than the 12% for service sires of all registered cows. The lack of emphasis on yield traits was partially explained by a low or missing final score for type for the elite cow, which may have made her unacceptable as a bull-dam. The number of service sires and the modest service sire merit suggest that elite Holstein cows are underutilized. However, dependence on elite designation for selection of bull-dams is decreasing, as evidenced by the many young cows without evaluations that were mated to produce sons for sampling.

(**Key words**: genetics, service sire, elite cow)

Abbreviation key: MFP$ = economic index that combines genetic evaluations for milk, fat, and protein yields; **MOET** = multiple ovulation embryo transfer; **PA** = parent average.

INTRODUCTION

Rapid genetic progress depends on selection of parents of the highest merit to produce sons to be sampled. Emphasis has been placed on selection of sires of sons, but little is known about the success of mating outstanding cows to produce sons.

For this study, outstanding cows are defined as those designated as genetically elite by USDA (6). Those cows have the highest economic indexes based on genetic evaluations for milk, fat, and protein yields (**MFP$**) among registered cows thought to be alive. Percentiles for cows are assigned based on cows that are eligible for elite designation (registered and assumed to be alive based on calving date and termination code for latest lactation) (6). For Holsteins, elite cows are in percentile 99 for MFP$ (top 1% of eligible cows). The primary purpose of designation of cows as elite is to identify potential bull-dams. Actual matings also consider type (conformation) and other traits. For example, most AI organizations prefer that cows have a final score of at least 80 to be considered as a potential bull-dam (D. Selner, 1992, personal communication).

Bulls are assigned a percentile based on the MFP$ for a breed's bulls that are designated as being in active AI service prior to the current semiannual evaluation (9). The animal model permits bull and cow evaluations to be directly comparable. Table 1 shows minimum MFP$ required for Holstein bulls in January 1990 to achieve various percentiles among active AI bulls and the cow percentile for that MFP$. Only the top 30% of active AI bulls would

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TABLE 1. Minimum MFP$[1] required for Holstein bulls to achieve various percentiles among active AI bulls and the cow percentile for that MFP$.

Bull percentile	MFP$	Cow percentile
90	201	99.7
80	181	99.4
70	163	98.9
60	150	98.3
50	139	97.5

[1]MFP$ = ($.0605/kg)PTA milk + ($3.26/kg)PTA fat + ($3.15/kg)PTA protein.

have been elite (percentile 99) had they been female. Although all active AI bulls have undergone intense selection, further selection among them is necessary to choose sires of the next generation of bulls to be sampled. For each semiannual evaluation since 1990, 50 to 60 bulls have been at a percentile of at least 90. Because this group of bulls is so large, a mean percentile of at least 95 for bull-sires is recommended. That level is quite modest compared with the 7 to 10 sires of sons per generation suggested by Banos and Smith (1) for a two-country population and the 2 to 6 sires per yr recommended by Goddard (3) for a global population.

Retaining elite cows and making use of all semen produced by the top bulls will not maximize progress unless those groups are mated to each other. The purpose of this study was to determine the extent of positive assortative mating among US Holstein dairy cattle that are genetically best for yield traits.

MATERIALS AND METHODS

For January 1990 USDA-DHIA evaluations, 8056 Holstein cows were designated as elite. Because service sire information is not included with data routinely provided to USDA by the nine dairy records processing centers, the identification of service sires for those cows was determined from pedigree data for resulting progeny. Such pedigree data are supplied routinely to USDA by the Holstein Association of America (Brattleboro, VT) as part of a reciprocal data exchange. Obtaining service sire data in this way results in considerable lag time between a service and reporting of progeny. Therefore, the elite Holstein cows were chosen from an evaluation calculated sufficiently long ago that resulting progeny would have been registered. Services occurring after elite designation in January 1990, but before arrival of new information in July 1990, would result in progeny born from November 1990 through April 1991, and genetic merit of their sires was investigated.

The 8056 elite cows had a total of 30,850 progeny in the USDA pedigree file; only 36% of those progeny were sons. Thus, many sons of elite cows appeared not to have been registered, probably because of a limited market for bulls in AI and for natural service. Sons that were registered had higher merit sires than did daughters that were registered, which substantiates that sons were selectively registered. Because nearly all daughters likely would be registered, this study focused primarily on service sires of daughters to describe service sire merit more accurately.

Information from only one daughter per elite cow was considered in the primary data file. However, through multiple ovulation embryo transfer (**MOET**), cows could have had multiple daughters born in a given period. The single daughter was selected by earliest birth date. If daughters had identical birth dates, the daughter with the lowest registration number was chosen. Choice of the daughter had almost no impact because MOET daughters generally have the same sire.

Merit of service sires for elite cows was determined by MFP$ calculated from PTA for milk, fat, and protein (kilograms) for those bulls in January 1990. That index was

$$\begin{aligned} \text{MFP\$} = {} & (\$.0605/\text{kg})\text{PTA milk} \\ & + (\$3.26/\text{kg})\text{PTA fat} \\ & + (\$3.15/\text{kg})\text{PTA protein.} \end{aligned}$$

This formula was used for MFP$ even if PTA were from an evaluation since January 1990. Any MFP$ value that was based on other than January 1990 PTA for cows or bulls is identified in this report.

Selection criteria for yield may include factors other than MFP$, but MFP$ has been the basis for percentile rankings since July 1989 and has been the standard ranking criterion for presentation of bull lists by dairy magazines and AI advertisers. If service sires are selected using a different indicator of yield merit or based on nonyield traits, their mean MFP$ will be less than if selection were based only on MFP$, thus reflecting different breeding objectives.

For service sires without a PTA in January 1990, parent average (**PA**) for MFP$ was used as merit of service sire if available at that time. In addition, PA for MFP$ and sampling codes were obtained from July 1992 genetic evaluations. Sampling codes were S, M, or O (8) as defined and reported through the National Association of Animal Breeders. Code S (stud sampled) indicates that the bull had semen distributed randomly to at least 40 herds by an organization active in all aspects of AI (semen collection, processing, and marketing). Code M (multiple herd sampled) is assigned to bulls sampled similarly but not by a full service AI organization. Code O (other sampling) is assigned to bulls reported to the National Association of Animal Breeders that do not meet requirements of codes S or M or to bulls not assigned those codes by the time that the bull is 3 yr old. A fourth group of bulls with no sampling code reported also was investigated.

As a comparison, supplementary data files also were examined that included 1) daughters born from June 1990 through October 1990, 2) daughters born from May 1991 through September 1991, and 3) sons born from November 1990 through April 1991. To explore the impact of MOET, data for all daughters and sons born from November 1990 through April 1991 (rather than one daughter or son per cow) were examined to provide a weighted analysis. Service sire information for registered daughters born from November 1990 through April 1991 for all cows also was investigated.

In recognition of nonyield requirements for bull-dams, the effect of final score on service sire MFP$ was studied. Although final score is a phenotypic measure, it is a factor in the selection of bull-dams. Final scores available at mating were provided by the Holstein Association of America for the 8056 elite cows.

Because elite cows were expected to be the core group from which dams of sons for AI would be selected, bulls born from November 1990 through April 1991 and sampled by eight major AI organizations were studied to determine which dams and service sires actually produced bulls for AI sampling.

RESULTS AND DISCUSSION

The 8056 cows designated as elite in January 1990 were born from 1977 through 1987; median birth date was August 1985. The most frequent birth year was 1986 (39% of cows). The frequencies for numbers of lactations for cow evaluations were 48.1, 27.6, 14.9, 7.0, and 2.5% for lactations 1 through 5. Although these frequencies emphasize that the best genetics are identified by the youngest cows, many of these cows would have already calved again at the time of evaluation because of the delay between receipt of data and distribution of genetic evaluations. All cows that were eligible for elite designation (i.e., that met all requirements except MFP$ level) averaged $5 for MFP$. For elite cows, MFP$ was $166 or higher and had a mean of $192 and a median of $185.

Daughters were identified from the pedigree file for 6550 of the 8056 elite cows. One of these daughters was selected for each cow: 1295 born from November 1990 through April 1991, 959 born during the prior 5 mo, and 629 born during the following 5 mo. Other daughters were born outside the 16-mo period, or a daughter was one of multiple daughters. Of the 959 daughters born from April 1990 through October 1990, 141 daughters resulted from matings before the cow had an evaluation that included her lactation information. Such matings produced daughters born when the cow was less than 1212 d old (about 40 mo) and were births that initiated one of the cow's first two lactations.

The 1295 elite cows with daughters born from November 1990 through April 1991 had 209 service sires. Of those sires, 133 bulls had only one daughter. This number of service sires contrasts sharply with the suggestion of Goddard (3) that use of the two to six best bulls worldwide to produce the next generation of sons would optimize genetic gain. Two bulls (one at percentile 94 and the other at percentile 93) did have substantial use and were the service sire for 23 and 17% of matings. However, no other bull was a service sire for more than 5% of matings. The top five bulls for MFP$ were not initially sampled by full service AI organizations (code S); although their type evaluations were high, together they accounted for only 5% of services. Most services were to bulls in AI (1071 to

TABLE 2. Numbers of services to sires without genetic evaluations in January 1990 and parent averages (PA) for MFP$[1] by sampling status of bull.

Sampling code	Number of services	Number of services to bulls with PA	PA MFP$ $\overline{X}$	PA MFP$ Percentile
S[2]	35	18	113	26
M[3]	11	5	188	84
O[4]	22	7	140	50
None	28	1	81	10

[1]MFP$ = ($.0605/kg)PTA milk + ($3.26/kg)PTA fat + ($3.15/kg)PTA protein.

[2]Stud sampled: bull had semen distributed randomly to at least 40 herds by an organization active in all aspects of AI.

[3]Multiherd sampled: bull sampled similarly to code S but not by a full service AI organization.

[4]Other sampling: bull does not meet S or M code requirements or was not assigned an S or M code by 3 yr of age.

code S bulls, 53 to code M bulls, and 129 to code O bulls); 42 services were to bulls with no sampling code.

For 96 elite cows (7%), no evaluation was available for the service sire. Frequencies of bulls' sampling codes are in Table 2 for those services. Some services to bulls without a sampling code were to natural service bulls used after unsuccessful AI matings. However, most matings were to AI bulls. In July 1992, bulls for 67 of those services still had no published evaluation. If breeding elite cows to bulls without evaluations is to increase the rate of genetic progress, producers must be willing to progeny test sons. Powell and Norman (7) have shown that bulls being sampled are genetically comparable with bulls in active service on average. However, elite cows should be mated to the best bulls, and accuracy of choosing the best bulls is limited in the absence of progeny evaluations.

Drawbacks to mating elite cows to bulls without evaluations are the risk of using a service sire that eventually is determined to be of lower genetic merit and the decreased acceptability of resulting sons for sampling programs. For the 31 services to bulls without evaluations but with PA for MFP$ (Table 2), the means and percentiles for PA for MFP$ show that these services were to bulls of lower genetic merit. By mid-1992, two to three times as much data were available for calculating PA for bulls without evaluations in January 1990. For services to bulls without January 1990 evaluations but with PA for MFP$ based on July 1992 evaluations, means for PA for MFP$ calculated with prices for 1990 evaluations were $144 (percentile 53) for code S, $199 (percentile 88) for code M, $85 (percentile 12) for code O, and $123 (percentile 35) for services to bulls with no sampling code. For services 5 mo before November 1990 and 5 mo after April 1991, corresponding mean PA for MFP$ for 126 services to bulls without January 1990 evaluations but with PA based on July 1992 evaluations were $173 (percentile 75), $209 (percentile 92), $98 (percentile 17), and $157 (percentile 65). Genetic merit, as indicated by PA, was low to moderate for service sires without evaluations; therefore, the lower merit of service sires originally found for the 96 elite cows was not the result of small sample size.

This lower PA for service sires without evaluations is of further concern; Ferris et al. (2) have reported that PA often overestimates eventual bull PTA. Overestimation of genetic merit of bull-dams contributes to overestimation of PA. Although the animal model forces PA and PTA to agree across all animals in the long term, a cow's inflated evaluation can persist until information from her progeny, particularly her sons, causes her evaluation to represent her actual genetic merit better.

Mean service sire MFP$ for the 1199 elite cows mated to bulls with January 1990 evaluations was $207 (percentile 91). On average, MFP$ for service sires with evaluations changed by –$11 from January 1990 to July 1992 (SD = $31.5). Most service sires that increased in merit by more than 1 SD had sampling code S, whereas most that decreased by more than 1 SD had sampling code O. Correlation between service sire reliability in

January 1990 and the change in MFP$ from then to July 1992 was .45. Thus, higher reliability bulls tended to increase in MFP$, and lower reliability bulls tended to decrease.

The frequency distribution of services by service sire percentile for MFP$ (Table 3) shows that only 13% of elite cows were mated to service sires at or above percentile 95 (top 5%). Five percent of matings were to service sires below percentile 50.

TABLE 3. Frequencies of services by service sire percentile for MFP$.[1]

Percentile for MFP$	Services		
	Number	Percentage	Cumulative percentage
99	36	3.0	3.0
98	40	3.3	6.3
97	36	3.0	9.3
96	2	.2	9.5
95	43	3.6	13.1
94	293	24.4	37.5
93	281	23.4	61.0
92	16	1.3	62.3
91	108	9.0	71.3
90	4	.3	71.6
80 to 89	192	16.0	87.7
70 to 79	34	2.8	90.5
60 to 69	34	2.8	93.3
50 to 59	22	1.8	95.2
40 to 49	29	2.4	97.6
30 to 39	7	.6	98.2
20 to 29	7	.6	98.7
10 to 19	11	.9	99.7
0 to 9	4	.3	100.0

[1]MFP$ = ($.0605/kg)PTA milk + ($3.26/kg)PTA fat + ($3.15/kg)PTA protein.

Supplemental Studies

Registered Daughters of All Cows. Service sire data were examined for the 153,415 Holstein cows with registered daughters born from November 1990 through April 1991. Mean MFP$ for the 77% of services made to sires with a January 1990 evaluation was $174 (percentile 75). Twelve percent of these service sires were at or above percentile 95 compared with 13% for elite cows, but only 33% were at or above percentile 90 compared with 72% for elite cows. Although service sires for elite cows generally were genetically superior to those used for all registered cows, the selection intensity was far from the recommended minimum percentile of 90 for bull-sires. Correlation between dam and sire MFP$ was .20, which indicated positive assortative mating. However, a lower correlation would have been expected if computed within herd.

All Daughters of Elite Cows. Because the top cows are superovulated to produce many embryos, their impact on the population is in proportion to their numbers of progeny. When all daughters born to elite cows from November 1990 through April 1991 were considered rather than only one daughter per cow, the number of daughters almost doubled (2352 daughters), indicating substantial use of superovulation, because only progeny of one sex were included. Mean service sire MFP$ increased from $207 to $211, which indicated use of better bulls for superovulated cows. However, because the difference was not large, those data were not examined further.

Single Sons of Elite Cows. Data for dams of sons born from November 1990 through April 1991 (one son per cow) that corresponded to data for dams for the primary daughter data file included 858 services (one-third less than for daughters). Four percent of services for dams of sons were to sires without January 1990 evaluations compared with 7% for dams of daughters. Mean service sire MFP$ was $212 (percentile 92) versus $207 for daughters. Service sires producing reported bull-calves were more likely to have evaluations and to be of higher merit than those producing daughters, which is evidence of some selective registration for bulls.

All Sons of Elite Cows. If all sons born to elite cows from November 1990 through April 1991 were included, the number of sons increased to 1569, which was almost double the number of single sons. Also, as with daughter data, mean service sire MFP$ was higher ($214) than on the unweighted (cow) basis ($212).

Daughters Born to Elite Cows Prior to November 1990. Mean service sire MFP$ for the 959 services (one daughter per cow) in the 5 mo preceding November 1990 was $190, which was lower than the $207 found for the primary 6 mo, probably because of genetic trend in available sires and because some cows were not previously designated as elite. For daughters used before the cow had a PTA, mean service sire MFP$ was $202. The number of services that produced those daughters was small (131), and final conclusions should not be drawn. However, the results invite speculation. Was merit of service sires for yield higher because producers foresaw elite status for the young cows? Was more emphasis placed on merit of service sires for yield than for type because cows were not yet identified as elite?

Daughters Born to Elite Cows After April 1991. For services (one daughter per cow) in the 5 mo following April 1991, mean service sire MFP$ was $204, which perhaps was lower than the $207 for services during the preceding 6 mo because of lack of incentive to use the best service sires if a cow no longer was designated as elite.

Effect of Final Score

One explanation for less use of the best MFP$ bulls as service sires for elite cows is that some elite cows were judged to be unacceptable bull-dams because they had no type evaluation or a low type score. Lack of an AI market for a prospective bull-calf may have resulted in a decision not to spend the money for a top sire. Final score data were available for 93% of cows designated as elite for yield and with daughters born from November 1990 through April 1991. The cow's final score at the service date for each progeny was chosen. The AI organizations are reluctant to consider bull-dams with a score below 80, and a score of 85 traditionally was required. Four final score categories were defined: no score, less than 85, 85 to 89, and 90 or above. Means for service sire merit for these final score categories are in Table 4. Service sire MFP$ was similar for elite cows with final score of at least 85, declined somewhat for cows with lower final score, and declined even more for cows without a final score. Mean service sire MFP$ based on sons were $213 for the 83 elite cows with a final score of 90 or above, $214 for the 483 cows scored 85 to 89, $207 for the 226 cows with scores below 85, and $211 for the 30 cows without final scores. Merit of service sires for sons followed the same pattern as for daughters except for elite cows without a final score, but the number of elite cows in that category was small.

TABLE 4. Mean service sire MFP$[1] and corresponding percentile according to final score category.

Final score category	Number of cows	Service sire	
		MFP$	Percentile
≥90	92	213	93
85 to 89	574	212	93
<85	448	202	90
None	85	190	84

[1]MFP$ = ($.0605/kg)PTA milk + ($3.26/kg)PTA fat + ($3.15/kg)PTA protein.

Correlation between cow and service sire MFP$ was .06 and was significant ($P < .05$). Correlation between cow final score (when available) and service sire MFP$ was .16 and was highly significant ($P < .01$). Thus, positive assortative mating is indicated for yield even for elite cows and between service sire merit for yield and cow merit for type.

AI-Sampled Bulls

From all bulls born between November 1990 and April 1991, 572 bulls were brought into AI sampling by eight major AI organizations: 51 sires were represented by 1 to 262 sons, but 3 sires accounted for 66% of bulls. Sires of 543 bulls had an MFP$ in January 1990, and their mean MFP$ was $214 (percentile 93); 13% of sires were below percentile 90. Some of the sires with lower MFP$ had increased considerably in estimated merit by the time that their sons were born. However, these sires were below percentile 90 when selected, and the breeders of the sons were astute or fortunate. Of the 14 lowest MFP$ sires (64 sons), one-half were among the top 100 bulls for the Type-Production Index (4) of the Holstein Association of America in July 1991 (≥868), 3 sires had high indexes (791 to 856), another had a slightly above average index (572), and the remaining 3 sires were among the bottom 4 bulls. These lowest bulls likely were chosen because they transmit red coat color.

Twenty-nine bull-sires did not have January 1990 evaluations. Of those sires, 11 were Canadian. Of the remaining 19 US sires, 10 had July 1992 evaluations; their mean MFP$ based on the 1990 MFP$ index was $209. Four US sires were not yet evaluated in July

TABLE 5. Mean dam and sire MFP$[1] for bulls entering AI sampling and born November 1990 through April 1991 but without designation of their dams as elite at mating according to dam age at bull birth.

Dam age	Number of bulls	Mean MFP$	
		Dam	Sire
(mo)			
<24	15	238	215
24 to 35	73	245	216
36 to 47	80	242	215
48 to 59	33	189	215
≥60	43	186	205

[1]MFP$ = ($.0605/kg)PTA milk + ($3.26/kg)PTA fat + ($3.15/kg)PTA protein.

1992 but had a mean PA for MFP$ of $234. The two remaining US sires did not have pedigree data reported; therefore, their sires and dams were not known. Two of the Canadian sires also did not have pedigree data available.

Only 324 of the 568 known dams were elite cows in January 1990. Their mean MFP$ was $226. All 568 dams were evaluated in July 1992; their PTA produced a mean MFP$ of $236 based on the 1990 MFP$ index. The July 1992 MFP$ for the 324 elite cows had risen by $18 to $244. Adjustment of the $236 for all dams by $18 suggests that the mean MFP$ in January 1990 for other than elite cows was about $218, which is still high. Failure of dams to be designated as elite could occur from use of cows of low genetic merit but was more often the result of mating heifers or cows that were too young to have an official yield evaluation (Table 5). The earliest mating that could have been based on cow PTA would have been after the second calving (unless a cow had been intentionally left open). Nieuwhof et al. (5) reported an average age at third calving of 54 mo for registered Holsteins. Of the bull-dams that were not designated as elite when mated, 79% were 54 mo of age or younger, and those dams accounted for 34% of all dams of the bulls sampled. Some dams that were 60 mo of age or older may have been donors without a calving in over 2 yr and thus were assumed to be unavailable and were not designated as elite. Mean dam merit for the three youngest dam age groups was similar and much higher than for the two oldest groups, which also were similar to each other. Service sire merit was similar for all dam age groups, although the oldest dams were mated to sires with somewhat lower MFP$. Many older dams may have been chosen as bull-dams because of reputation and past phenotypic performance rather than current relative genetic merit.

Data on final score were available for the 324 elite dams of bulls entering AI sampling. Although a final score of 85 was not a requirement for a cow to be considered as a bull-dam, the frequencies of final scores in Table 6 i ndicate that score was important, particularly at mating. In general, final scores of bull-dams increased from mating to when the son was 4 mo of age and then to the most recent final score through early June 1992. Seventy-nine percent of bull-dams had final scores of at least 85 at mating, and that percentage had increased to 91% 13 mo later and to 92% for most recent score. At least part of the increase in final score would result from sons of cows that declined in score failing to enter into AI. An interesting aspect of the frequency distribution for final score is the low incidence of final scores of 84 and, particularly, 89.

Breeders, dairy producers, and AI personnel are expectedly defensive when faced with a

TABLE 6. Frequencies of final scores by cow appraisal date for elite cows that were dams of bulls entering AI sampling.

Final score	Number of cows according to appraisal date		
	Most recent prior to mating	Most recent prior to son's reaching 4 mo of age	Most recent through early June 1992
≥90	23	35	52
89	1	2	3
88	33	49	65
87	38	56	50
86	57	85	74
85	105	68	53
84	6	7	6
83	17	12	10
82	11	6	5
81	7	1	1
80	9	0	1
<80	3	0	1
No score	14	3	3

suggestion that the best use has not been made of the best cows. The AI organizations can only be held accountable for the matings that they did or did not make, and many matings were made without advice from AI organizations. Regardless of the decision maker, reluctance to use service sires that either are not AI sampled (sampling code of S) or do not have high reliability may be justified when decisions are made on matings to produce sons. Of 30 active AI bulls at or above percentile 95 for MFP$ in January 1990, only 12 bulls were AI sampled, and only one of those 12 was at least +1 for PTA type. This reluctance may explain the relatively limited use of bulls at percentile 95 and above. However, 8 of the 12 AI-sampled bulls did have positive PTA type evaluations. Of the 63 bulls at or above percentile 90, 35 were AI sampled. Of the 28 other bulls, 16 were still in active service in July 1992. For the 25 AI-sampled bulls that had positive PTA type evaluations, mean MFP$ was $218, which was not much above the mean of $214 for the sires of bulls born from November 1990 to April 1991 that entered AI sampling. However, differential usage was not considered for those bull-sires.

CONCLUSIONS

Elite Holstein cows could be mated to bulls with higher genetic merit. Many more bulls were used than recommended for optimal genetic gain. The major reason for not using many of the bulls with the highest percentiles as service sires for elite cows likely was that they were not AI sampled. Seven percent of elite cows were mated to bulls that were not only without evaluations but had generally low pedigree promise. Of evaluated service sires, 5% were below percentile 50, and only 13% were at or above percentile 95. Substantial use of bulls (primarily 2) in percentiles 93 and 94 resulted in 71% of services to bulls of at least percentile 90 and a mean of percentile 91, which is below the mean recommended (percentile 95) for optimizing genetic gain. Less than optimal mating for yield (MFP$) is partially explained by a low or missing type appraisal (final score) for the elite cow, which may have made her unacceptable as a bull-dam. Emphasis on conformation characteristics other than final score also lowers sire merit for MFP$. An obvious question for the dairy industry is how much emphasis to place on type, particularly on phenotypic traits, if reduced improvement for yield is the result.

A bull superior for MFP$ also may be bypassed because of potential inbreeding. However, the effect of inbreeding on average service sire merit should be small. The top six active AI bulls for MFP$ had different sires, and the top 12 had 10 different sires.

The top bulls for MFP$ are not necessarily the top bulls for PTA for protein yield. Therefore, emphasis on protein in early 1990 would have affected average MFP$. The top 10 bulls for PTA for protein yield were in the top 14 for MFP$ except for one that ranked 45th. However, 2 bulls at percentile 97 for PTA for protein yield were at percentiles 80 and 89 for MFP$.

The adequacy of the delivery system for information on elite status of cows also may need to be addressed. Currently, information on elite status is provided on computer tape to AI organizations, breed associations, and the DHIA system through the dairy records processing centers and on microfiche to state extension specialists. Accessibility of elite information to a dairy producer depends on the distribution practices of the servicing processing center, knowledge of where to obtain the information, and personal interest. Electronic access to such information is growing but may meet only a small part of the distribution need in the near future.

Bulls entering AI sampling had sires at percentile 93 and often had dams that were not designated as elite. Most of these dams were too young at mating to have a PTA, which reflects the willingness of breeders and AI organizations to take risks based on their knowledge that a PTA will be available when the son is ready to be sampled. In general, older dams were of much lower genetic merit for yield as has been reported by Ferris et al. (2). Bulls chosen for AI sampling were not always the result of mating the best bulls to the best cows, which is necessary for maximum genetic gain.

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